# ON THE PEAT DEPOSITS OF MOINE MHOR

BY

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# ON THE PEAT DEPOSITS OF MOINE MHOR

By CHARLES G. C. CHESTERS.

(*With eight Figures in the Text.*)

Much detailed research has been carried out on the identification of remains discovered in post- and inter-Glacial peat deposits in the British Isles, Europe and North America, and a large amount of data has accumulated with regard to the correlation of these remains. Attempts have also been made to trace the development of woodlands from the fossilised pollen of the peat. The general condition of the vegetation during the periods which lie between the end of the Glacial time and the end of the Sub-Atlantic time (**5**) has often been discussed, but so far no very detailed and systematic investigations have been made on the succession of vegetation which developed on the surface of the several raised beaches which occur round the western sea-board of Britain.

This paper records the results of a general investigation of the various peat strata formed on the surface of the 50-ft. raised beach which surrounds the head of Loch Crinan, in Argyllshire, and underlies the moorland of Moine Mhor (Fig. 1). A salt marsh has developed on the shoreward side of the present beach, and a gradual transition occurs between the salt marsh vegetation and the vegetation of the moorland, so that an investigation of the lower layers of the peat resting on the surface of the raised beach might yield evidences of any former salt marsh vegetation which was formed on the surface of that older beach.

Davis (**3**) has studied the peat underlying salt marshes at Boston and has shown that, where the peat contains salt marsh plant remains, the species present are those that grow near high-tide mark at the present time.

It is possible that the surface of the raised beach might have been invaded directly by a type of moorland or a scrub vegetation, and it has been recorded by Lewis (**6**) that birch, hazel and alder remains were found covering the surface of the 25-ft. raised beach in the case of the Moss of Cree (lying between Newton Stewart and Wigtown). These were followed, in the higher layers, by *Sphagnum*, *Eriophorum* and *Phragmites*. From evidence furnished by a study of other peat mosses he suggests that: "Interest should attach to an examination of any deep peat deposits resting on the 50-ft. raised beach—as we might expect to find in that case—the representatives of the Arctic Zone of the Merrick Mosses resting on the surface of the beach."

Erdtman (**4**) has described a peat moss occurring "at the 50-ft. raised beach," about 14 m. above sea level, and north-west of the upper end of Loch

Carron (Ross-shire). Pollen of *Alnus* and *Betula* was found throughout all the strata, and in larger quantity than pollen of *Pinus*. Pollen of *Corylus*, *Ulmus*

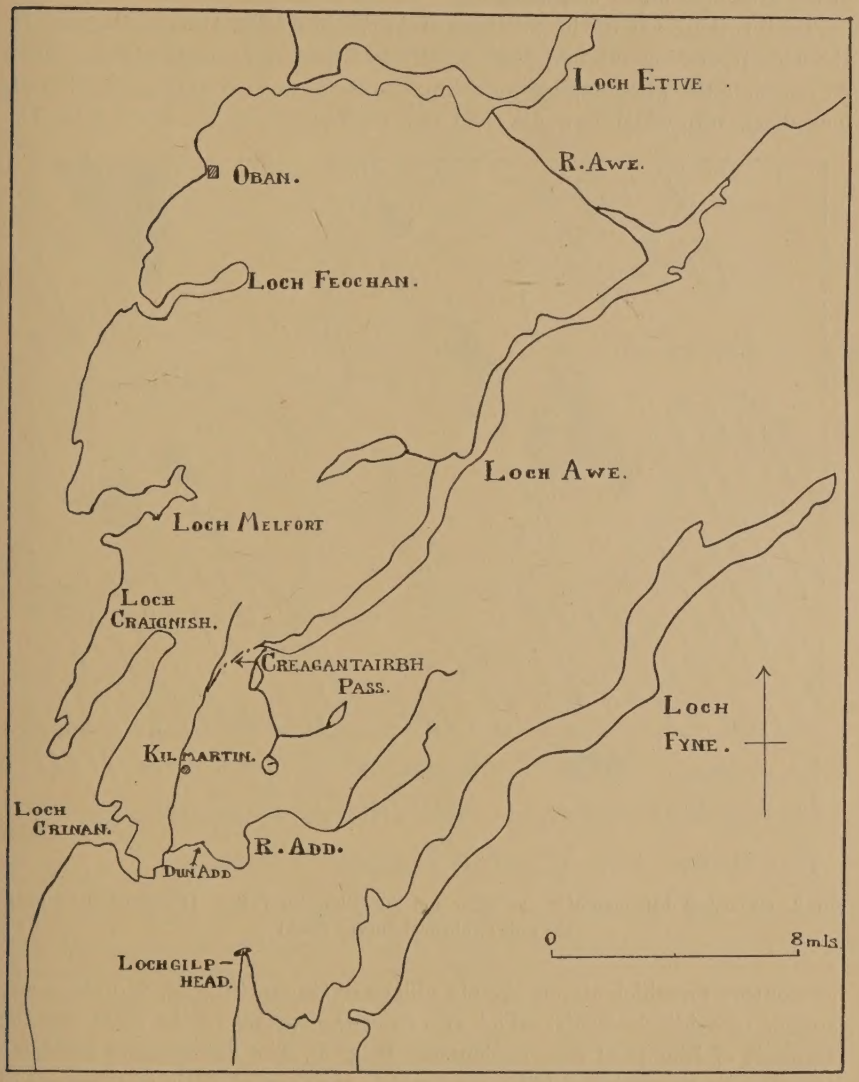


FIG. 1. Map of Northern Argyllshire showing the region surrounding Loch Crinan and the approximate position of the former exit of Loch Awe, during Glacial times, via the Creagantairbh Pass. (Based on the $\frac{1}{4}$ in. to the mile Geographical Survey map.)

and *Quercus* was less frequent, and was not represented in all the layers. The high frequency of *Alnus* pollen is outstanding in this moss.

Before beginning the description of the plant remains of the peat, it will be of interest to consider briefly the topography and the geological history of the area here under consideration.

Loch Crinan, one of the sea lochs of Argyllshire (Fig. 1), is surrounded by the wide tract of moorland known locally as Moine Mhor, or the Crinan Moss. At one time the whole region, including the Moss, was one large, almost land-locked sea, into which flowed a river now represented by the River Add. The

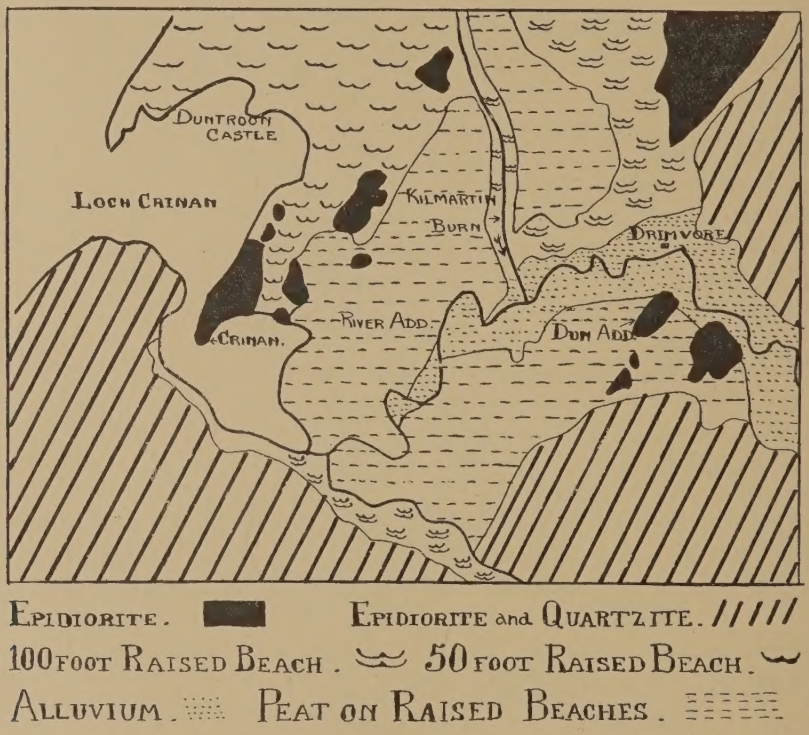


Fig. 2. Geological drift-map of Moine Mhor and the Kilmartin Valley. (Based on the ½ in. to the mile Geological Survey map.)

promontory on which stands the old village of Crinan (Fig. 3), and the many mounds of epidiorite schist which rise from the surface of the Moss, are the remnants of islands of that ancient sea (Fig. 2). The flat expanse of Moine Mhor breaks the series of hill ranges which are characteristic of this part of Argyllshire, and separates the highlands of North Knapdale from those of more northern Argyll.

At present the River Add alone serves to carry the drainage water of these Argyllshire hills to the sea, but in late Glacial times the overflow water of Loch Awe escaped over the watershed into the Add, due to the damming

back of its former exit by ice. At a later date, when the ice had somewhat retreated, the drainage water of the Loch escaped through the Creagantairbh Pass (Fig. 1) into the Kilmartin Valley, and, via the course of the present Kilmartin Burn, joined the River Add (7). Aided by these two distinct streams at different periods, the Add appears to have silted up the higher

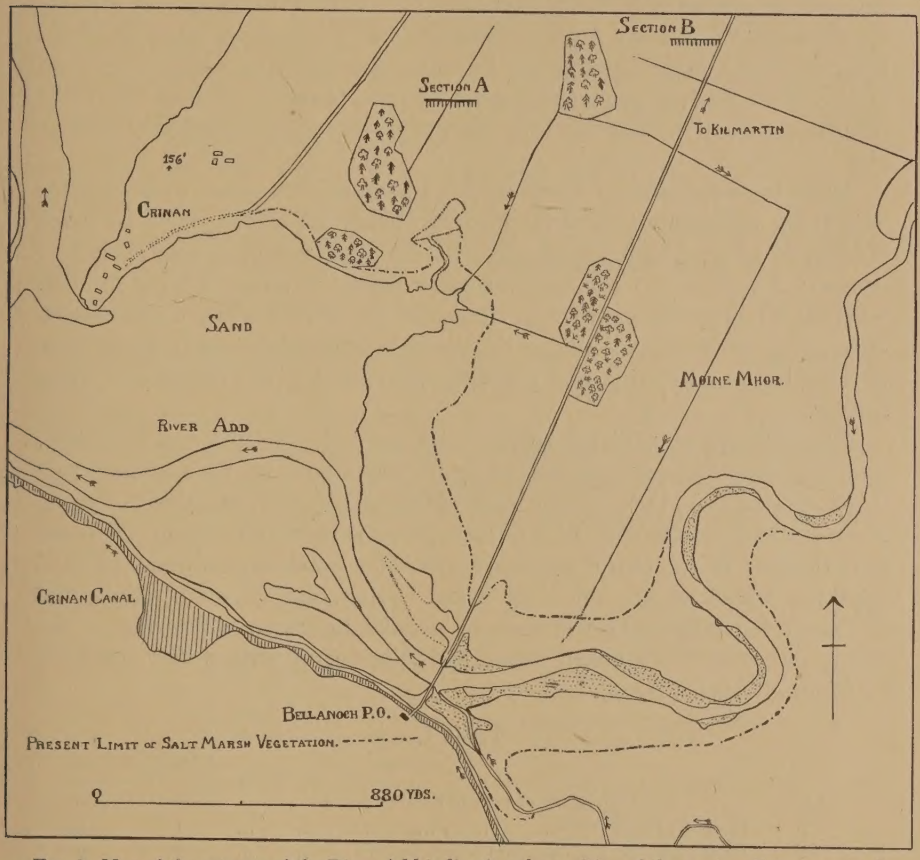


FIG. 3. Map of the estuary of the River Add indicating the position of the peat sections examined and the approximate limit of salt marsh vegetation at the present time. (Based on the 6 in. to the mile Geographical Survey map.)

portion of the inland sea. Later, the general rise of the west coast of Scotland caused the formation of the 100-ft. beach, which passes round the head of Moine Mhor and extends upwards into the Kilmartin Valley (Fig. 2). A further uplift formed the 50-ft. beach on which the peat of the lower, or seaward part, of Moine Mhor has been deposited (Fig. 2). Along the course of the Add the 50-ft. beach is masked by several river terraces and alluvial deposits, but, along the Bellanoch-Kilmartin road, the transition from fine sand on the

seaward side of the moor to coarse sand and gravel near the village of Kilmartin, can be followed in the various sections which have been cut for the excavation of peat fuel.

Boulder clay occurs below the 50-ft. raised beach and outcrops between tide levels in a bay south of Duntroon Castle (Fig. 2). In this blue-grey clay thirty-three species of Mollusca have been identified by Crosskey and Robertson (2) many of which are Arctic or Boreal forms. Its presence below the 50-ft. beach of Moine Mhor is suggested by numerous exposures along the course of the River Add; a particularly good section, near the farm of Drimvore (Fig. 2), shows 10 ft. of horizontally bedded gravel resting on stiff grey boulder clay.

There is a dominance of *Nardus stricta* and *Scirpus caespitosa* in the vegetation of the central portion of the moor, and they are accompanied by *Erica cinerea*, *E. tetralix*, *Calluna vulgaris*, *Molinia caerulea* and various species of *Juncus*; *Juncus squarrosus* covering large tracts of wet, low-lying ground, where it is mainly associated with *Sphagnum* sp. On the western and eastern edge of the moor, and also along the higher reaches of the Add, *Myrica gale* dominates the vegetation and is mainly associated with *Calluna* and *Erica tetralix*.

The outcrops of epidiorite schist—with the single exception of Dun Add, an old Scottish fortress—are covered by woodland in which the dominant tree is *Pinus sylvestris*, but in some cases *Picea* also occurs, along with *Betula*, *Fraxinus* and *Corylus* (Fig. 3). The last species is more common in the woods near the sea. It is doubtful whether or not these woods are natural, and local tradition speaks of the pines, at least, having been planted. Along the Bellanoch-Kilmartin road two areas of woodland occur on the surface of the moor, and consist of a mixed *Betula* and *Alnus* scrub with a very few trees of *Pinus sylvestris* (Fig. 3).

Table I.

| Layer | Character of peat of Section A | Depth of layer inches | Depth of layer cm. |
|---|---|---|---|
| 8 | Present subsoil ... ... ... ... ... ... | 1 | 2·5 |
| 7 | Dark brown peat of open and coarse texture ... ... | 8 | 20·0 |
| 6 | Dark brown peat of close texture with a band of light brown moss peat ¾ in. (1·8 cm.) deep in the centre ... ... | 6 | 15·0 |
| 5 | Light brown peat of open texture ... ... ... ... | 4 | 10·0 |
| 4 | Brown peat of close texture ... ... ... ... ... | 10 | 25·0 |
| 3 | Dark brown peat of very close texture ... ... ... | 18 | 45·0 |
| 2 | Fine black peat ... ... ... ... ... ... | 4 | 10·0 |
| 1 | Fine silver sand representing the surface of the 50-ft. raised beach ... ... ... ... ... ... | — | — |
| | Total depth ... ... ... ... ... ... | 51 | 127·5 |

The peat examined was collected from two sections used for cutting peats, the one, lying E.N.E. of the old village of Crinan behind one of the wooded

mounds; the other, about 1½ miles N.N.E. of Bellanoch. The sections are marked A and B respectively (Fig. 3), and the depth and character of the several layers present is given in Tables I and II.

Table II.

| Layer | Character of peat of Section B | Depth of layer inches | Depth of layer cm. |
|---|---|---|---|
| 8 | Present subsoil ... ... ... ... ... ... | 1 | 2·5 |
| 7 | Dark brown gritty peat ... ... ... ... ... | 3 | 7·5 |
| 6 | Dark brown granular peat with a layer of grit separating it from 7 ... ... ... ... ... ... ... | 11 | 27·5 |
| 5 | Very light brown spongy peat ... ... ... ... | 2 | 5·0 |
| 4 | Light brown peat consisting of an upper layer of open texture and a lower layer of close texture ... ... | 12 | 30·0 |
| 3 | Dark brown peat, the upper layers being laminated ... | 18 | 45·0 |
| 2 | Hard black peat containing 23 per cent. of fine sand ... | 9 | 22·5 |
| 1 | Coarse sand and gravel with worn pebbles—representing the top of the 50-ft. raised beach ... ... ... | — | — |
| | Total depth ... ... ... ... ... ... | 56 | 140·0 |

Representative portions of each layer in the two sections, including the surface of the raised beach, were cut from fresh surfaces of the peat. Half of each portion was macerated in 40 per cent. NaOH for 6 hours. The material was then filtered through a perforated porcelain filter, and the filtrate centrifugalised and examined for pollen grains. The larger remains were extracted from the solid material on the filter by soaking it in a large volume of water.

Table III.

| Layer | Section A | Section B |
|---|---|---|
| 7 | Hypnum cupressiforme | Hypnum Schreberi |
| 6 | H. cupressiforme<br>H. Schreberi | H. cupressiforme<br>H. Schreberi<br>Dicranum scoparium |
| 5 | H. Schreberi<br>Hylocomium squarrosum | Sphagnum cymbifolium<br>Hylocomium loreum |
| 4 | Sphagnum cymbifolium<br>Dicranella heteromalla | *Upper layer*<br>Sphagnum fimbriatum<br>S. cymbifolium<br>Dicranella heteromalla<br>Aulacomnium palustre<br>Hylocomium squarrosum<br>*Lower layer*<br>Dicranella heteromalla<br>Hylocomium loreum<br>Hypnum Schreberi<br>H. cupressiforme |
| 3 | Hypnum Schreberi<br>H. cupressiforme<br>Plagiothecium denticulatum<br>Aulacomnium palustre | None<br><br><br>None |
| 2 and 1 | None | None |

Mosses play an important part in the constitution of the peat of both sections, but they occur at a lower level in Section A than in Section B.

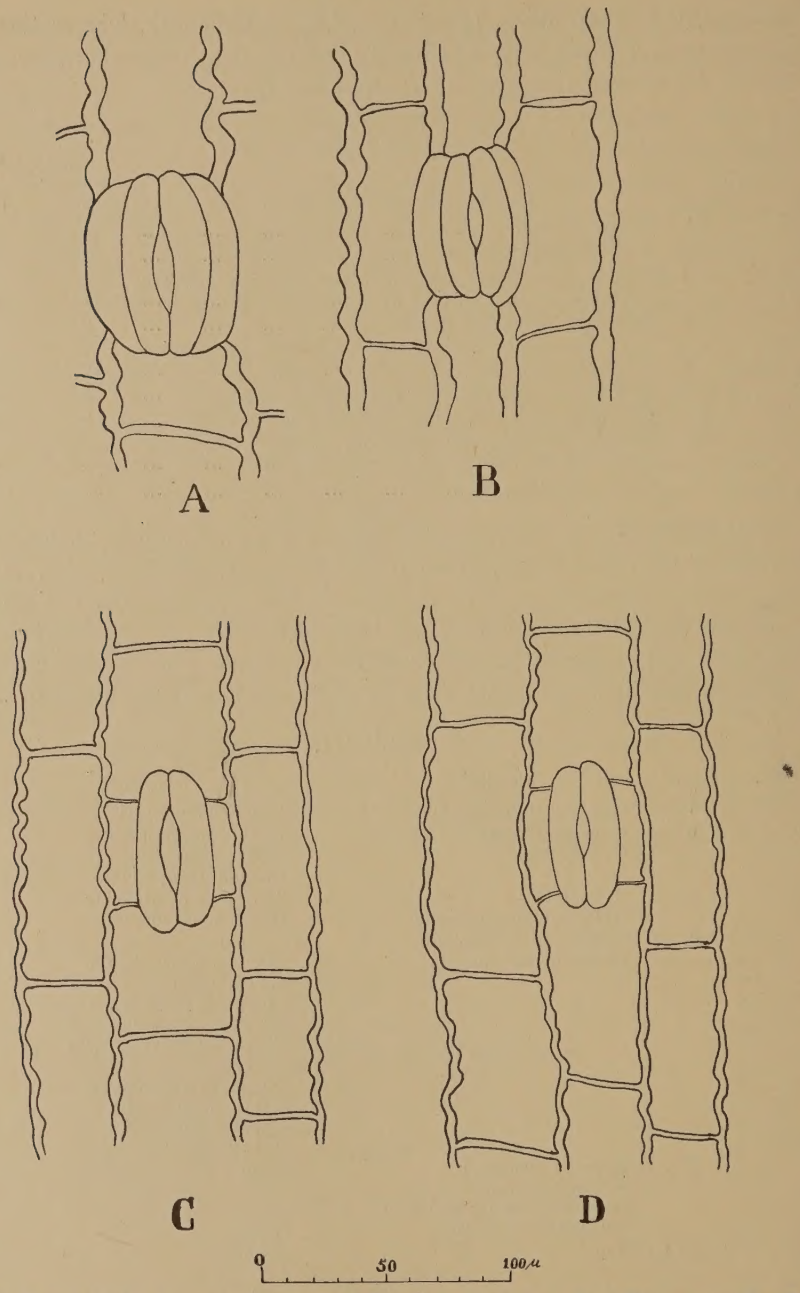


FIG. 4. Camera lucida drawings of stomata of *Eriophorum* and *Carex* from living material and material preserved in peat. A. Stoma of *Eriophorum vaginatum*. B. Stoma of *Eriophorum* sp. from peat. C. Stoma of *Carex binervis*. D. Stoma of *Carex* sp. from peat.

*Sphagnum* spp. were present in almost every layer along with other mosses, but they are only recorded from those layers in which both leaves and stems

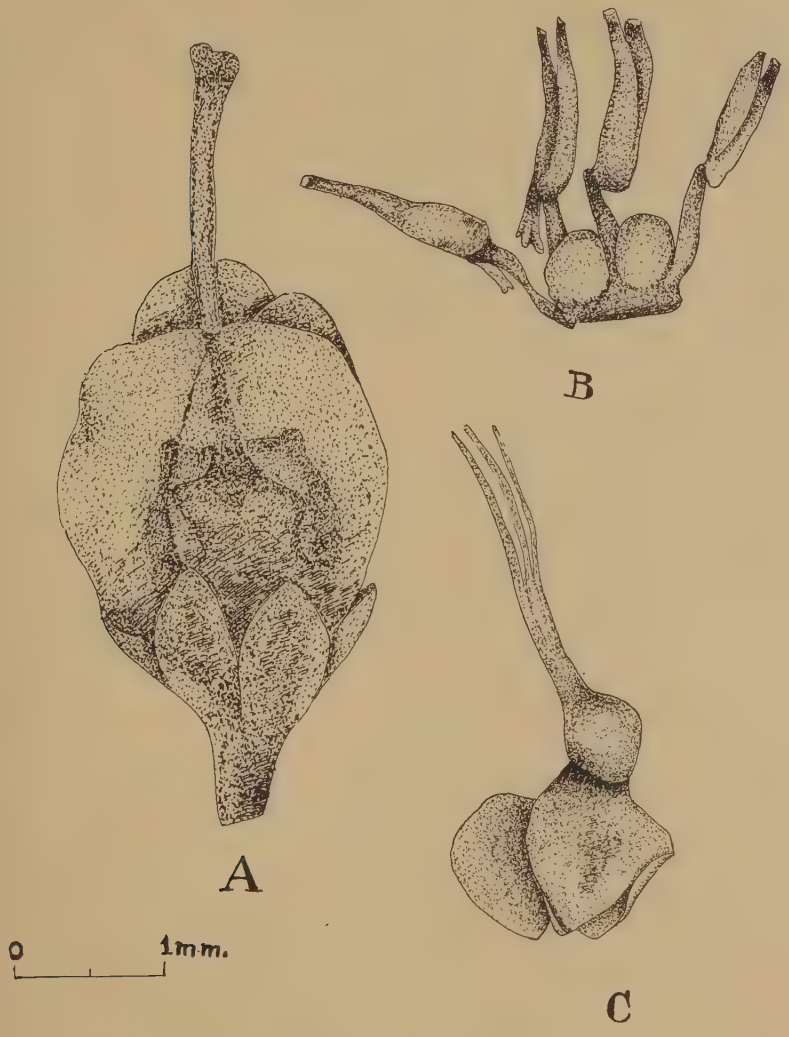


FIG. 5. A. Flower of *Calluna*. B. Anthers of *Calluna*. C. Fruit of *Carex* sp. Isolated from peat.

were present, or fragments of complete plants occurred. All the mosses were identified by, and classified in accordance with H. M. Dixon's *Student's Handbook of British Mosses* (3rd edition). The mosses present in the various layers are indicated in Table III.

All the species isolated are characteristic of either a moorland or woodland vegetation of the present time. No clearly marked succession is evident, as, for example, from Arctic to more temperate types, or from mosses characteristic of damp situations to those of drier. Local variations, such as may be encountered in any woodland or moorland, appear to be indicated by the occurrence of *Aulacomnium palustre*, which would indicate a damper situation, but there appears no striking variation or interruption of their occurrence such as might be expected if a gradual transition from one type of vegetation to another had occurred.

Few of the phanerogamic remains were in a high state of preservation either in the natural peat or in the material left after maceration, and those portions extracted were mainly parts of stem, bark, leaves, leaf "cuticles," flowers and fruits. The leaves and flowers were most perfectly preserved, and

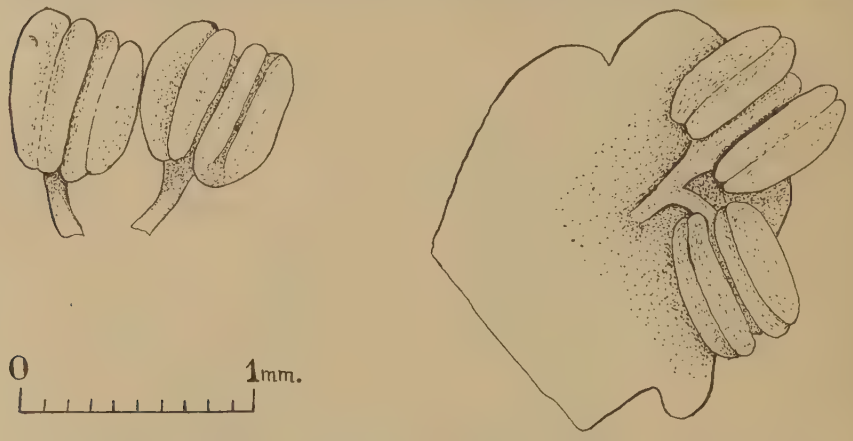


Fig. 6. Separate anthers, and stamen attached to bract, of *Betula* isolated from peat.

in some cases were easily identified. The majority of the remains belonged either to the Ericaceae, *Betula* or *Myrica*. Numerous graminaceous cuticles were encountered, and after comparison with living types, as suggested by Bandulska (**1**) in the case of the Fagaceae, it was possible to distinguish *Carex*, *Eriophorum* and *Juncus* cuticles from those of the true grasses (Fig. 4). Several flowers of *Calluna* and isolated anthers of that species (Figs. 5, A, B), a group of anthers of *Betula* (Fig. 6), and a single *Carex* fruit (Fig. 5 C) were obtained. A grass panicle, resembling an opened panicle of *Festuca*, was recovered from one of the higher layers. A systematic table of these remains from the two sections is given in Tables IV and V.

The results stated lead to the conclusion that any succession of vegetation which has occurred represents the gradual encroachment of a moorland type of vegetation on a birch heath. Remains of birch trunks have been noted in the lower layers of other sections than the two described at about the surface

of the raised beach, and for some 3 ft. above the beach surface. In the material examined, many badly decomposed remains of stems, whose bark resembled that of *Betula*, were dug from layers 3 and 4; but only in the case of layer 3 of Section A was it possible to compare the wood under the microscope with that of present-day birch wood, when it was evident that the preserved wood belonged to the same species.

From the evidence of the moss flora and that of the higher plant remains, the assumption seems justified that Moine Mhor has, from very early times, been covered with a type of vegetation which is essentially similar to that of any present lowland moor. The earlier layers appear to suggest that the moorland was slowly encroaching upon a birch heath in which clumps of trees were separated by areas of *Calluna*, more or less extensive. Damper periods must have existed during the succession, as is suggested by the presence of mosses such as *Sphagnum* and *Aulacomnium*, and by the presence of *Erica tetralix*, *Juncus* sp. and *Myrica*.

FIG. 7. Photograph of leaves of *Myrica* from peat. Note the characteristic serration of the apex of the lower leaf.

Table IV. *Section A.*

| Layer | Specimens identified |
|---|---|
| 7 | Leaves of *Eriophorum*, *Juncus* and *Myrica* |
| 6 | Stems of *Calluna*. One fruit of *Carex* (sp. ?). Leaves of *Eriophorum* and *Myrica*, and scale leaves of *Juncus* |
| 5 | Stems of *Myrica*. *Carex* stomata |
| 4 | Stems of *Erica tetralix*. Leaves of *Erica tetralix*, *Carex* and *Juncus* (spp.). Flowers of *Calluna* |
| 3 | Stems of *Betula* and *Calluna*. Leaves of *Myrica* (Fig. 7). Remains of leaves and stems of *Juncus* (sp.) and a grass. Stamens and bract of *Betula* |
| 2 | *Juncus* (sp.) stem and basal leaves |
| 1 | Sand of "raised beach" |

There is no positive indication that the surface of the raised beach has ever been covered by salt marsh vegetation, but it appears probable that the more central region of the Moine Mhor remained in a marshy condition in its

early stages of development, as is suggested by the high percentage of sand in layer 2 of Section B. The presence of a considerable amount of chitinous material strongly suggests that aquatic animals of some type lived in the immediate vicinity of this layer.

Table V. *Section B.*

| Layer | Specimens identified |
|---|---|
| 7 | Remains of epidermis of *Juncus* (sp.). Grass panicle resembling *Festuca* |
| 6 | Stems of *Calluna*. Leaves of *Juncus* (sp.) |
| 5 | Decomposed remains of leaves represented only by their vascular skeleton |
| 4 | Terminal portions of stems of *Calluna*. Stems and attached leaves of *Erica tetralix*. Leaves and stems of *Myrica*. Abundant flowers of *Calluna*. Leaves and basal portions of stems of *Juncus*. Remains of a grass cuticle |
| 3 | Bark resembling that of *Betula*. Remains of Graminaceous cuticle |
| 2 | Remains badly preserved—no clear structural features observed |
| 1 | Sand with considerable amounts of chitinous material |

Study of the fossil pollen of the several layers of the two sections confirms, in a general way, the evidence derived from the phanerogamic remains. Pollen grains of *Betula* occur in almost every layer of the two sections and, in a large majority, pollen of the Ericaceae was found in considerable quantities; spores of *Sphagnum* (sp.) and pollen of grasses were less frequent. The number of pollen grains of *Alnus* and *Corylus* varied somewhat but never reached any large value (Fig. 8).

Preparations examined by Dr G. Erdtman, to whose kind assistance I am deeply indebted for the results stated, give an idea of the character of the pollen content of both sections. These preparations were made from material from Section B, and in layer 2 the following figures were obtained:

33 pollen grains of *Betula*
19 „ „ *Alnus*
4 „ „ *Corylus*
2 „ „ *Ulmus*
1 „ grain of *Ilex*
Tetrads of the Ericaceae
Pollen grains of Compositae and grasses
Spores of *Sphagnum* (sp.)

A preparation made from the material of layer 3 yielded:

40 pollen grains of *Betula*
3 „ „ *Alnus*
2 „ „ *Quercus*
3 „ „ *Corylus*
1 „ grain of *Pinus*
1 „ „ *Ulmus*
1 „ „ *Carpinus* (doubtful)
1 „ „ an Umbelliferae
1 „ „ a Caryophyllaceae
Tetrads of the Ericaceae
Pollen grains of grasses

In layer 7 the following were obtained:

27 pollen grains of *Betula*
3 „ „ *Corylus*
1 „ grain of *Pinus*
1 „ „ *Alnus*
1 „ „ *Salix*
Tetrads of the Ericaceae
Spores of *Sphagnum* (sp.)

These results add confirmation to the view expressed above, that the early vegetation on the surface of the 50-ft. raised beach must have resembled a birch heath, and that during the succession which followed a gradual change

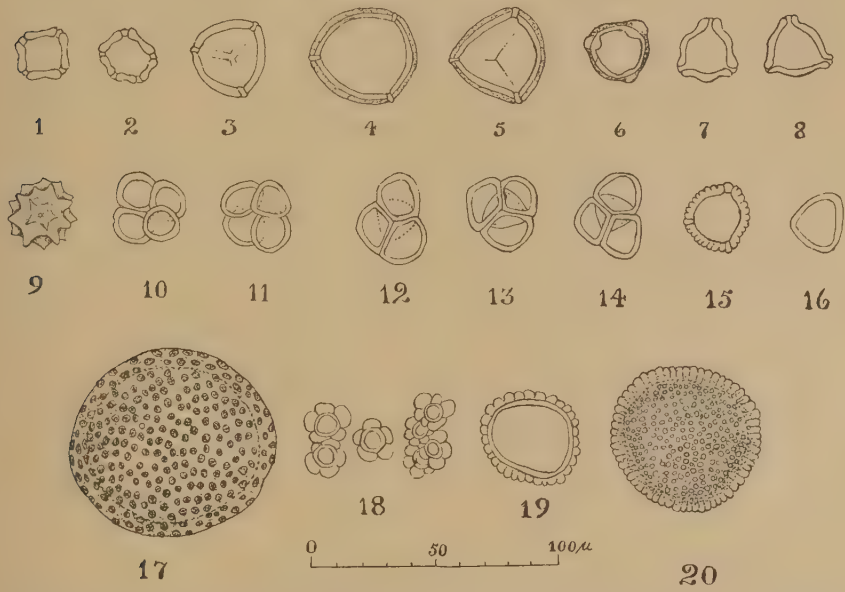


FIG. 8. Camera lucida drawings of pollen grains and animal remains from peat. 1, 2. Pollen of *Alnus*. 3, 4, 5, 6. Spores of *Sphagnum* (sp.). 7, 8. Pollen of *Betula*. 9. Pollen of a Composite. 10–14. Tetrads of the Ericaceae. 15. Pollen of *Salix* (?). 16–20. Animal remains.

to a purely moorland type occurred. This may in part have been due to a slight climatic change, as vegetation of a birch heath type is still found on the sides of the foothills surrounding Moine Mhor, but at several feet above its surface. Even if it were suggested that transference of pollen by wind from surrounding wooded areas might account for some of the pollen grains found in the peat strata, it is impossible that this should have any very serious influence on the results, and when the pollen statistics are coupled with the occurrence of macroscopic remains, more or less conclusive evidence of a wider extension of *Betula* than at present is indicated.

The investigation of two sections in such an extensive area of moorland cannot be said to yield, in any way, conclusive evidence of the history of the

moor, but, from the results, as far as they go, there appears to be no evidence of the existence of a former salt marsh vegetation on the surface of the raised beach. Exactly the contrary is indicated, that woodland, or at least a birch heath with numerous areas of *Betula* and other trees, was established at an early date. Again, the evidence does not support the view expressed by Lewis (**6**), that representatives of an Arctic flora should be found on the surface of the 50-ft. raised beach.

All the results suggest a close comparison between the succession of vegetation over the surface of the 50-ft. raised beach of Moine Mhor and that over the 50-ft. raised beach north-west of the upper end of Loch Carron, as recorded by Erdtman (**4**), but without the markedly high frequency of alder pollen.

The peat deposits over the raised beach at Crinan appear to be of recent origin. This is indicated by the presence of *Alnus* pollen, and by the almost entire absence of *Pinus* pollen. *Alnus*, according to the researches of Erdtman, was a late immigrant into Scotland, and its appearance in the peat of Moine Mhor would suggest that all of the peat was Post-Boreal. Between early Post-Boreal times and the present a definite maximum of *Pinus* pollen occurred, in Scotland, in Sub-Boreal times. The very low frequency of *Pinus* pollen, in the layers where it does occur, and its entire absence in others, would suggest that the peat of Moine Mhor was formed at some time after the *Pinus* maximum in Sub-Boreal times. It is probable that almost all, if not all, the peat of Moine Mhor has been deposited between the commencement of Sub-Atlantic times and the present day.

Deposition of peat is still going on, and in some of the oldest trenches used for "peat cutting," fresh layers of very recent origin, containing remains of *Eriophorum* and *Erica tetralix*, have been formed over the surface of the old workings.

It may be concluded, then, that in the area of Moine Mhor which is covered by the present investigations, there is no evidence either of the occurrence of salt marsh vegetation on the surface of the 50-ft. raised beach, or of the presence of any Arctic flora. The remains which have been examined are all those of typical moorland or woodland plants, and from the pollen statistics, taken in conjunction with the other results, it is suggested that the peat is of recent origin, the earliest layers probably dating back to Sub-Atlantic times.

In conclusion I desire to express my thanks to Mr W. Leach for his help and criticism during the preparation of this paper.

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